

Enlistment Early Warning System Study



Briefing to Army Recruiting Research Consortium

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**Institute for Defense
Analyses**

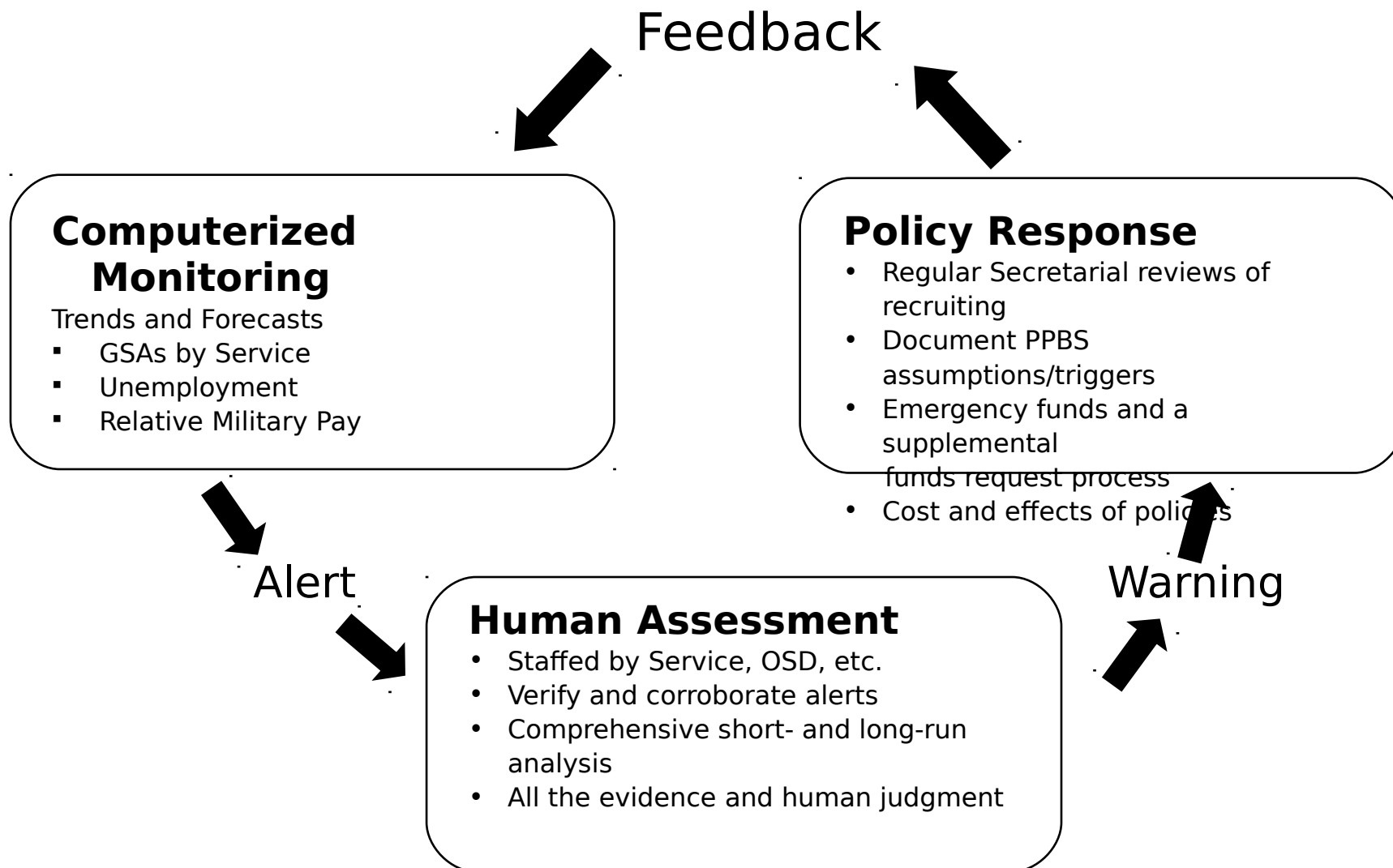
lgoldber@ida.org

Executive Summary

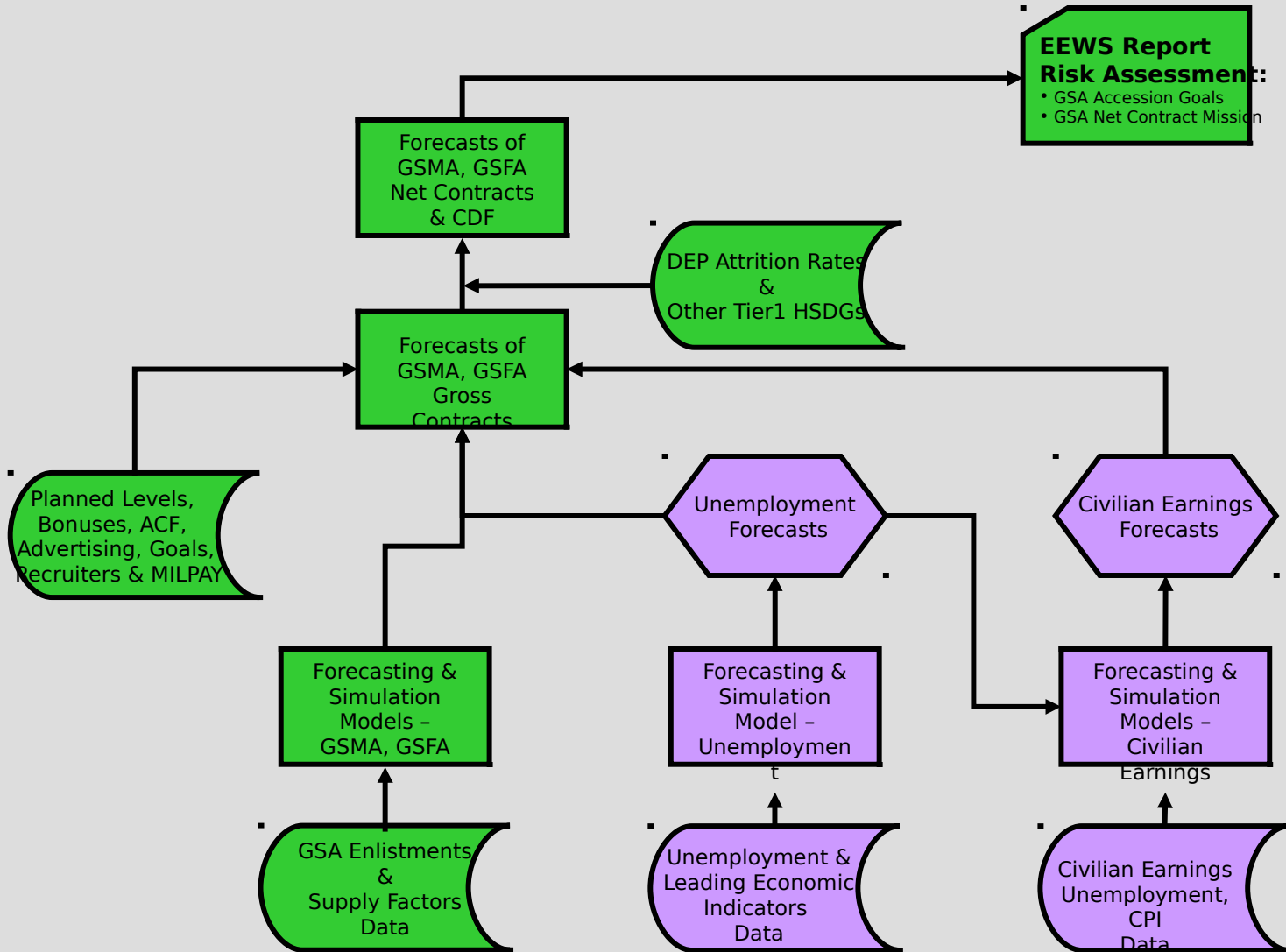
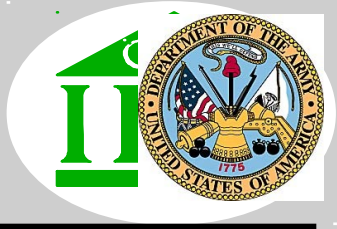


- DOD responds too slowly to upturns in the economy
 - Accession crises and waste
 - *Need Crisis Prevention Management*
- Created credible, accurate and timely Enlistment Early Warning System (EEWS) for each Service
- Annual forecasting error for high quality enlistments is 1-3 % for each Service
- Implement *Crisis Prevention Management*
 - Run the EEWS
 - Change management system and undertake policy analyses

Enlistment Crisis Prevention Management



Army Enlistment Early Warning System

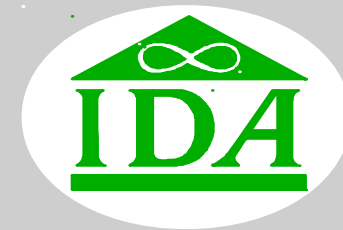


Army Enlistment Forecasting Models



- Log-linear specification
- Dependent variables
 - GSMA enlistments
 - GSFA enlistments
- Independent variables
 - Relative military pay
 - Unemployment
 - Expected education benefits/cost of college
 - Expected bonuses/CPI
 - Recruiters
 - Net contract missions per recruiter
 - Advertising
 - Dummies for months (seasonality)
 - Moving average error terms
- Estimated using “RATS” software

Definitions of Variables



Variable	Definition	Data Source/Period
GSMA	Gross contracts: NPS male, 1-3A, HSDG + HSSR	DMDC; 10/78-9/01
GSFA	Gross contracts: NPS female, 1-3A, HSDG + HSSR	DMDC; 10/92-9/01
Military Pay	$BPY_1 + BPY_2/1.3 + BPY_3/1.3^2 + BPY_4/1.3^4$ where BPY = expected basic pay @ actual TIG Army; 5-month moving average centered on the current month	BPY from OUSD/Comp, 10/78-9/01; TIG from OSD/EPM, 10/78-9/99
Civilian Pay	$CPY_{18} + CPY_{19}/1.3 + CPY_{20}/1.3^2 + CPY_{21}/1.3^4$ where CPY = average annual earnings of HSG's who work full time; by gender; 5-month moving average centered on the current month	Current Population Surveys (monthly Earnings files); from NBER 1/79-12/99, from CPS/BLS website 1/00-9/01
Relative Military Pay	PV Basic Pay ÷ PV Civilian Pay; by gender	
Unemployment	Unemployment rate total civilian labor force	CPS/BLS; 1/70-9/01
Recruiters	Regular Army production recruiters	USAREC; 10/78-9/01
Advertising	Total Regular Army media placement costs in thousands divided by cost indexes (base = 1983); weighted average over last 6 months; weights = 6/21, 5/21, ..., 1/21	Advertising data from USAREC, 10/78-9/01; media cost indexes from McKann-Erickson, NYC, 1/79-9/01

Definitions of Variables (continued)



Variable	Definition	Data Source/Period
GSMA Goal	GSMA net contract mission per recruiter: GSMA mission until FY 94; GSA mission goal for [NPS males/NPS accessions] since FY 1995	Net contract missions from USAREC, 10/80-9/01; % NPS accession male goal from HQDA/DAPE-MPA, 10/94-1/01
Other Goals	Total net contract mission minus GSMA (GSFA) mission per recruiter	USAREC; 10/80-9/01
GSFA Goal	GSFA mission per recruiter: GSFA mission for FY 92-94; GSA net mission goal for [NPS females/NPS accessions] since FY 1995	GSA net contract missions from USAREC, 10/86-9/01; % NPS female accession goal from HQDA/DAPE-MPA, 10/94-9/01
Bonus	Expected total bonus divided by CPI; sum for all programs X $X = AB, EB, HG, \text{ and } QS,$ $X = \sum_i \sum_j WMOS_i \times WTOS_j \times \$Bonus,$ $WMOS_i = \text{average percent NPS accessions in } MOS_i$ and $WTOS_j = \text{average percent NPS accessions in } TOS_j$	Bonuses by MOS/TOS, MOS and TOS weights, HQDA/DAPE-MPA, 10/79-9/01; CPI from BLS 10/79-9/01
ACF+MGIB	Expected present value of Army total education benefits, @ 3% discount rate, divided by annual cost of college (4-year public institution); MOS/TOS weighted measure similar to expected bonus	ACF by MOS/TOS, MOS and TOS weights, HQDA/DAPE-MPA, 1/79-9/01; cost of college from Dept. of Education 1/78-9/01

Army GSMA Model Sample 10/92-3/01



Dependent Variable ARMDS13A - Estimation by Nonlinear Least Squares

Monthly Data From 1992:10 To 2001:03

Usable Observations 102

Degrees of Freedom 81

Centered R**2 0.895060

R Bar**2 0.869149

Mean of Dependent Variable

7.9536314224

Std Error of Dependent Variable

0.1598465435

Standard Error of Estimate

0.0578217149

Sum of Squared Residuals

0.2708114075

Durbin-Watson Statistic

1.942284

<u>Variable</u>	<u>Coefficient</u>	<u>Std Error</u>	<u>T-Stat</u>
1. Constant	1.930455986	1.852619738	1.04201
2. RELPAY	0.698781184	0.277412850	2.51892
3. UNEMP	0.673693306	0.156912460	4.29343
4. GSMA goal	0.129288064	0.046695864	2.76873
5. Other goals	-0.048757928	0.055459259	-0.87917
6. Recruiters	0.570746415	0.193307016	2.95254
7. Bonus	0.034848072	0.026212187	1.32946
8. ACF+MGIB	0.138451759	0.086695179	1.59699
9. June	0.406774492	0.033602138	12.10561
10. July	0.333809106	0.040144069	8.31528
11. August	0.422854932	0.040861251	10.34856
12. September	0.258621633	0.039565366	6.53657
13. October	0.214705605	0.034682205	6.19066
14. November	0.122859018	0.036255241	3.38872
15. December	0.120823576	0.038523484	3.13636
16. January	0.194838813	0.037870046	5.14493
17. February	0.138908739	0.037789099	3.67589
18. March	0.192198019	0.029784462	6.45296
19. Mvg Avge{1}	0.487664651	0.112060892	4.35178
20. Mvg Avge{8}	-0.611269791	0.121435309	-5.03371
21. Mvg Avge{10}	-0.710007578	0.134701057	-5.27099

Effect of the Economic Boom on Army GSMA's: FY 1993 vs. FY 2000



From FY 1993 to FY 2000:

- Relative military pay declined by 14.1%
 - Elasticity of relative military pay 0.70
 - Effect of decline in pay = $14.1 \times 0.70 = 9.9\%$
- Unemployment declined by 43.0 %
 - Elasticity of unemployment rate 0.67
 - Effect of decline in unemployment = $43.0 \times 0.67 = 28.8\%$
- GSMA enlistments declined by 38.7%
 - $38.7 = 14.1 \times 0.70 + 43.0 \times 0.67$
- Because of increases in recruiters, missions, education benefits and bonuses, GSMA enlistments actually declined by 15.9%

Effect of the Economic Boom on All Services' GSMA's: FY 1993 vs. FY 2000



Service	Effect on GSMA's
Army	-38.7%
Navy	-27.5%
Air Force	-17.3%
Marine Corps	-11.4%

Army GSFA Model Sample 10/92-3/01



Dependent Variable ARFDS13A - Estimation by Nonlinear Least Squares

Monthly Data From 1992:10 To 2001:03

Usable Observations 102

Degrees of Freedom 85

Centered R**2 0.808499

R Bar**2 0.772452

Mean of Dependent Variable

6.7365971775

Std Error of Dependent Variable

0.1468450060

Standard Error of Estimate

0.0700480041

Sum of Squared Residuals

0.4170714450

Durbin-Watson Statistic

1.907136

<u>Variable</u>	<u>Coefficient</u>	<u>Std Error</u>	<u>T-Stat</u>
1. Constant	-0.581108661	2.352131222	-0.24706
2. RELPAY	0.798776166	0.361469549	2.20980
3. UNEMP	0.481720468	0.182930287	2.63336
4. GSFA goal	0.087064393	0.024665646	3.52978
5. Recruiters	0.610006356	0.255816891	2.38454
6. Advertising	0.195819241	0.069057795	2.83558
7. May	-0.061639818	0.027702126	-2.22509
8. June	0.164337001	0.032944988	4.98822
9. July	0.223264312	0.035047649	6.37031
10. August	0.312130315	0.040365516	7.73260
11. September	0.183510147	0.033156964	5.53459
12. October	0.074661864	0.026003455	2.87123
13. March	0.094736722	0.022474510	4.21530
14. Mvg Avge{1}	0.450781025	0.104267702	4.32330
15. Mvg Avge{2}	0.242735087	0.116567154	2.08236
16. Mvg Avge{3}	0.310770521	0.107398461	2.89362
17. Mvg Avge{10}	-0.193468585	0.103193772	-1.87481

Effect of the Economic Boom on All Services' GSFA's: FY 1993 vs. FY 2000



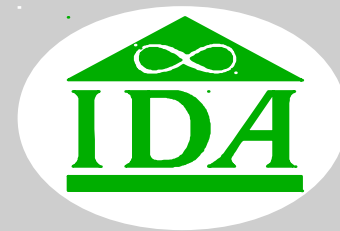
Service	Effect on GSFA's
Army	-25.7%
Navy	-30.7%
Air Force	-32.5%
Marine Corps	-29.2%

**Validation Tests 1 and 2 by Service
Percent Errors for Gross Contracts
April 2000-March 2001**



Service	Validation Test 1 Actual Values of Unemployment and Earnings	Validation Test 2 Forecasts of Unemployment and Earnings
Army	-1.59%	-3.05%
Navy	-1.25%	-1.91%
Air Force	-1.20%	-2.83%
Marines	0.17%	-0.71%

Risk Assessment Methodology

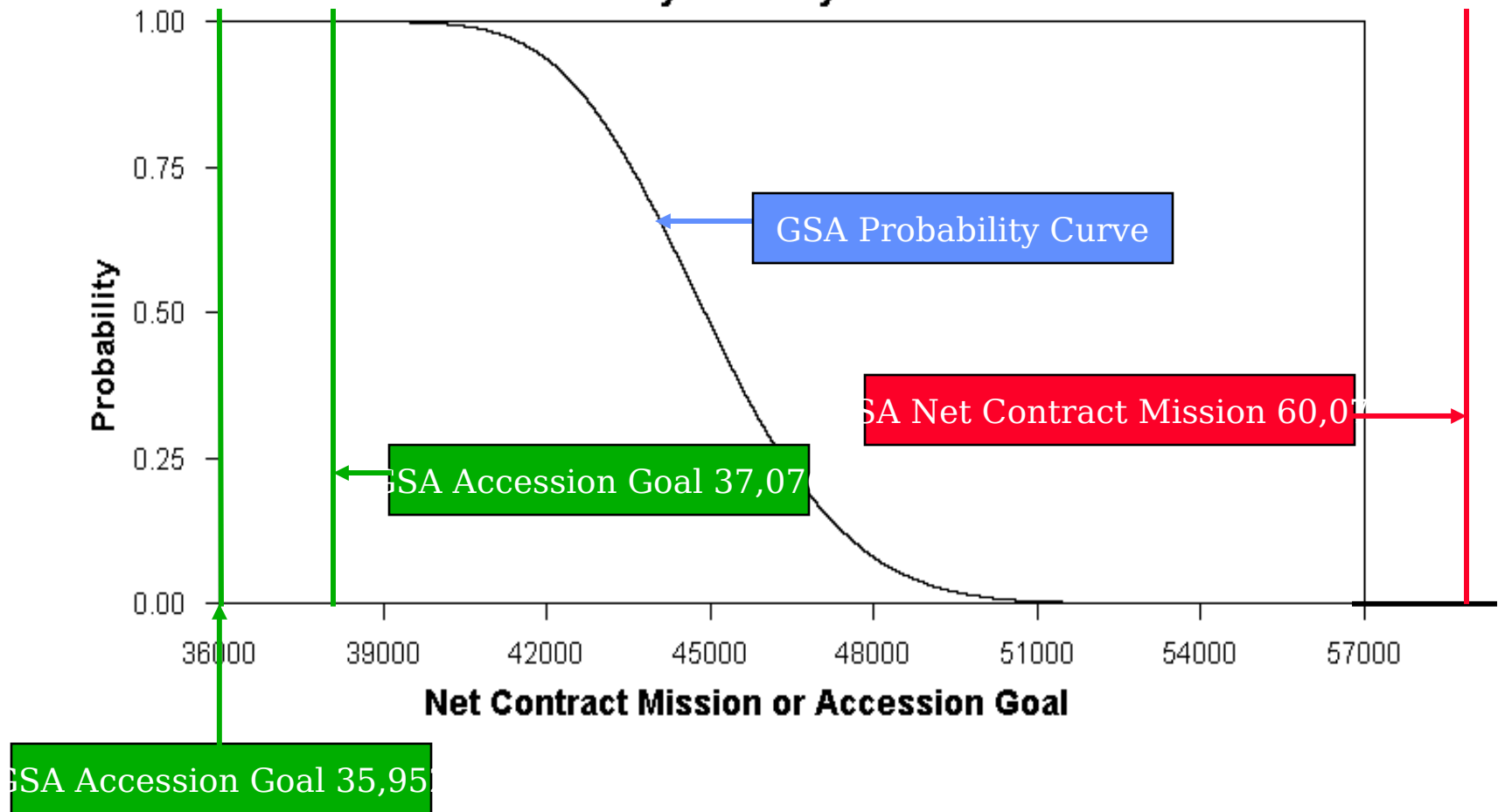


- Construct a probability distribution for GSA net contracts using computer simulations
- Takes into account uncertainty of
 - GSMA and GSFA models
 - Parameter estimates in the GSA models
 - Unemployment forecasts

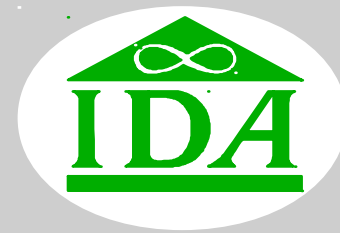
Army Risk Analysis: FY 2002 GSA Goals vs. Supply



Simulated Probability of Army GSA Net Contracts



Summary and Conclusions



- IDA has developed an EEWS for each Service
- Credible
 - Based on valid data and forecasting models
 - Developed by unbiased FFRC
 - Research documented and distributed; not a secret Army “black box”
- Accurate
 - Expect 1-3 percent forecasting error next 12 months
 - Somewhat higher error if the economy changes rapidly
- Timely
 - Monthly reports in 20-25 days for early detection of problems

Recommendations



- Minimize recognition and response lags
 - Update and run the EEWS monthly
 - Distribute EEWS research and monthly reports throughout the government
- Use the EEWS to
 - Prevent accession crises
 - Adjust recruiting resources (up and down)
- Implement *Crisis Prevention Management*
 - Change management system and undertake policy analyses

Future Studies



- EEWS maintenance and enhancement
- Policy response tool for DCSPERS
 - Model that minimizes recruiting costs subject to accessions *and* MOS mix constraints
- Management tools for USAREC
 - Mission allocation model
 - Station location model

Backup Slides



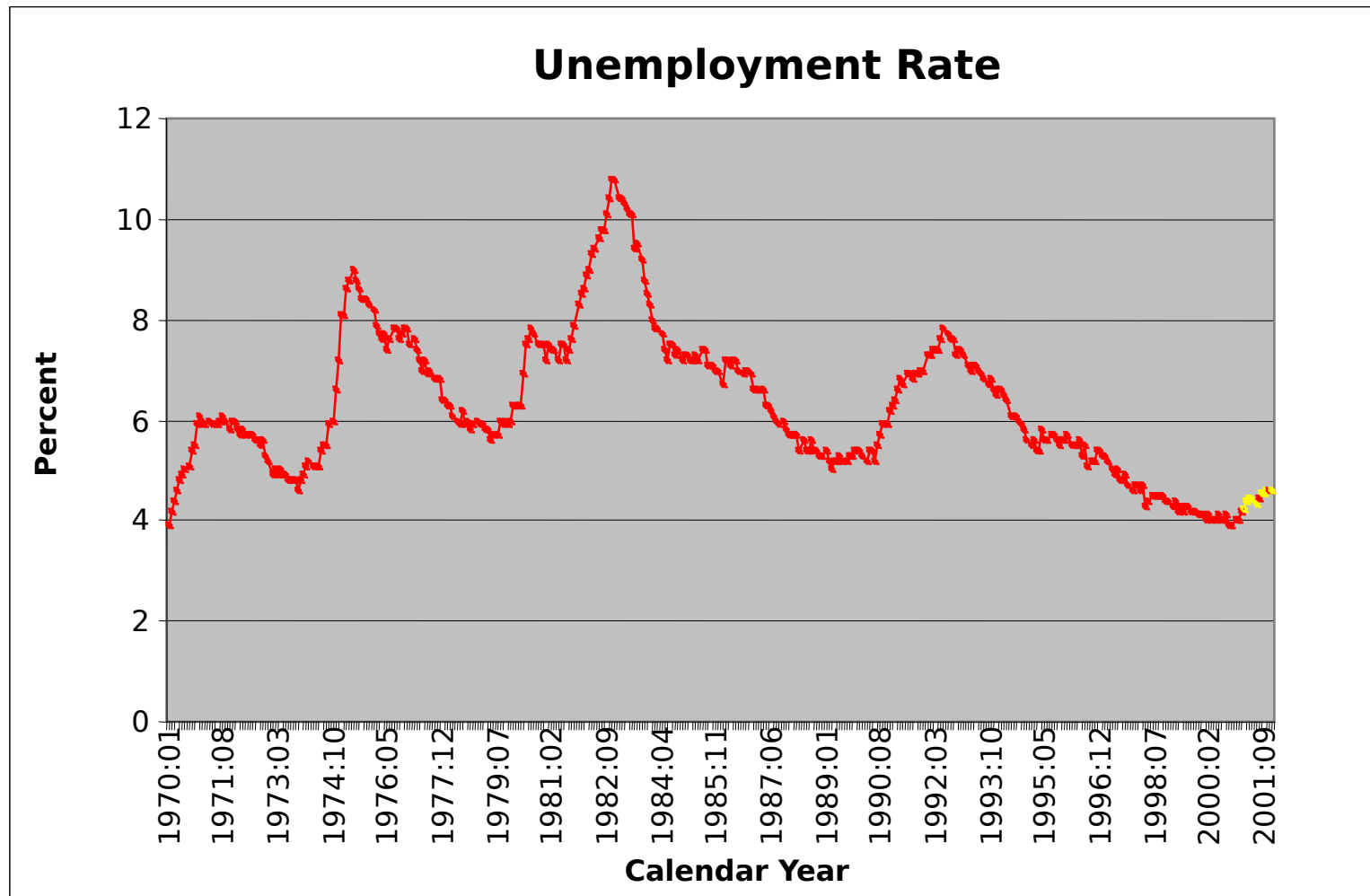
- Unemployment Model
- Civilian Earnings Models
- Total System Cost Management Model

Unemployment Model

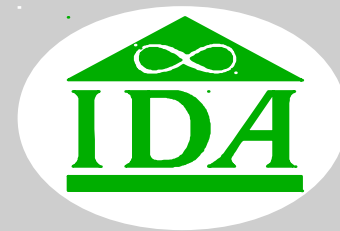


- Must forecast unemployment to forecast enlistments
- Dependent variable is the unemployment rate of the total civilian labor force
 - National monthly data from the CPS/BLS, 1/70-9/01
- Explanatory variables
 - Leading Economic Indicators (LEI) *lagged* 12 months
 - LEI data are U.S. government statistics (now) published by The Conference Board,
 - Lagged LEI data for 5/72-9/01
 - 15 LEI until 3/01; 12 LEI 4/01-9/01
 - Lagged unemployment
- Models estimated with observations for all or part of period 5/72-9/01, e.g.,
- Validation tests

Unemployment Rate Total Civilian Labor Force



Leading Economic Indicators

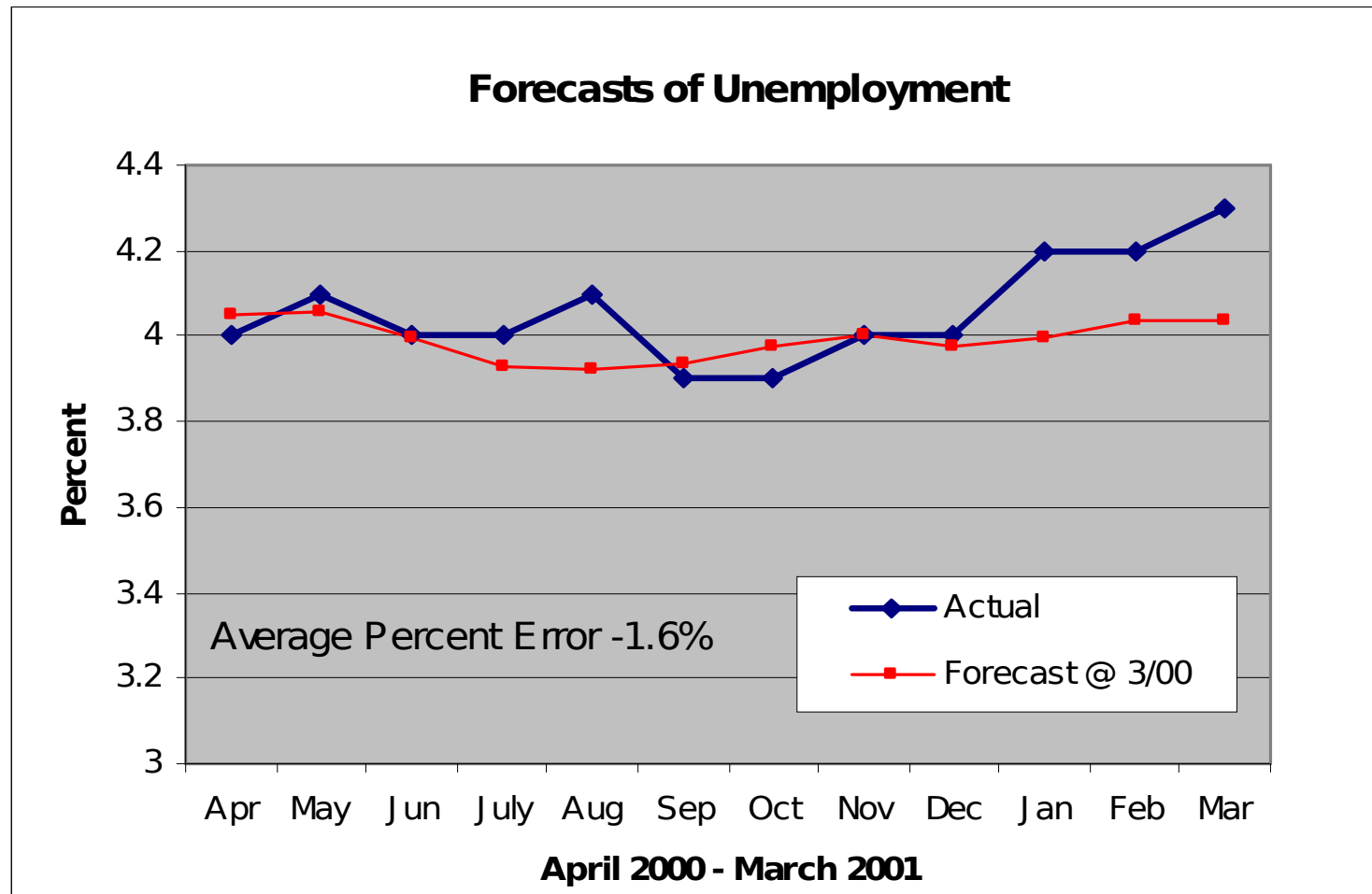


- **Composite index of 10 leading indicators [G0M910]**
- **Labor force, employment, and unemployment**
 - **Average weekly hours, mfg. [A0M001]**
 - **Average weekly initial claims, unemployment insurance [A0M005]**
 - **Average weekly overtime hours, mfg. [A0M021]**
 - **Index of help-wanted advertising in newspapers [A0M046]**
- **Output, production, and capacity utilization**
 - **Industrial production, nondurable manufactures [A0M074]**
 - **Industrial production, consumer goods [A0M075]**
- **Sales, orders, and deliveries**
 - **Mfrs' new orders, durable goods industries [A0M0007]***
 - **Mfrs' new orders, consumer goods and materials [A0M008]**
 - **Mfrs' unfilled orders, durable goods industries [A1M092]***
- **Fixed capital investment**
 - **Contracts & orders for plant and equipment [A0M020]***
 - **Mfrs' new orders, nondefense capital goods [A0M027]**
 - **New private housing units started [A0M028]**
- **Others**
 - **Money supply M2 [A0M106]**
 - **Index of 500 stock prices [U0M019]**

* Series temporarily unavailable for 4/01-9/01

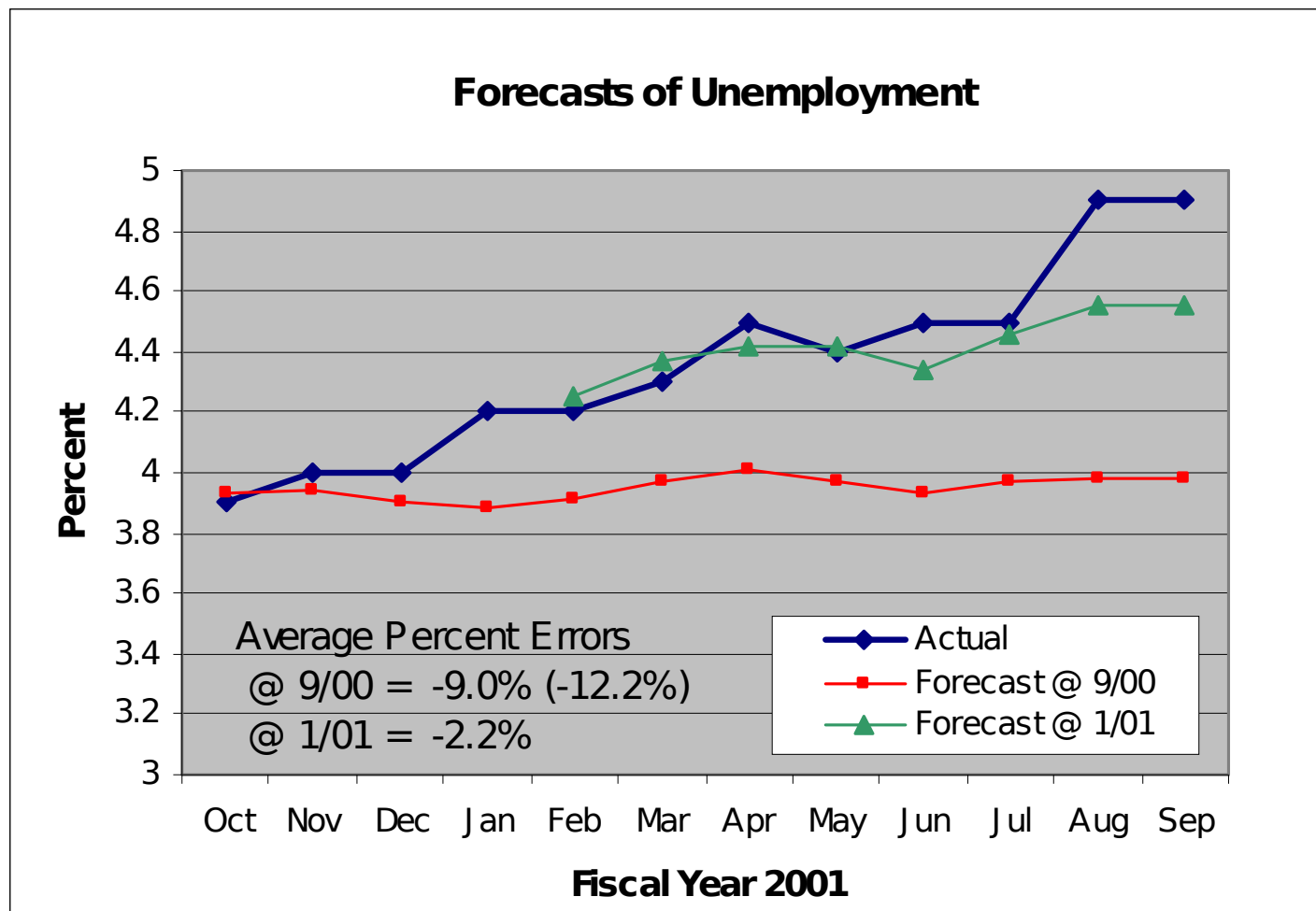
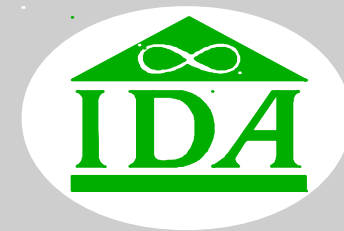
Validation Test

April 2000 - March 2001

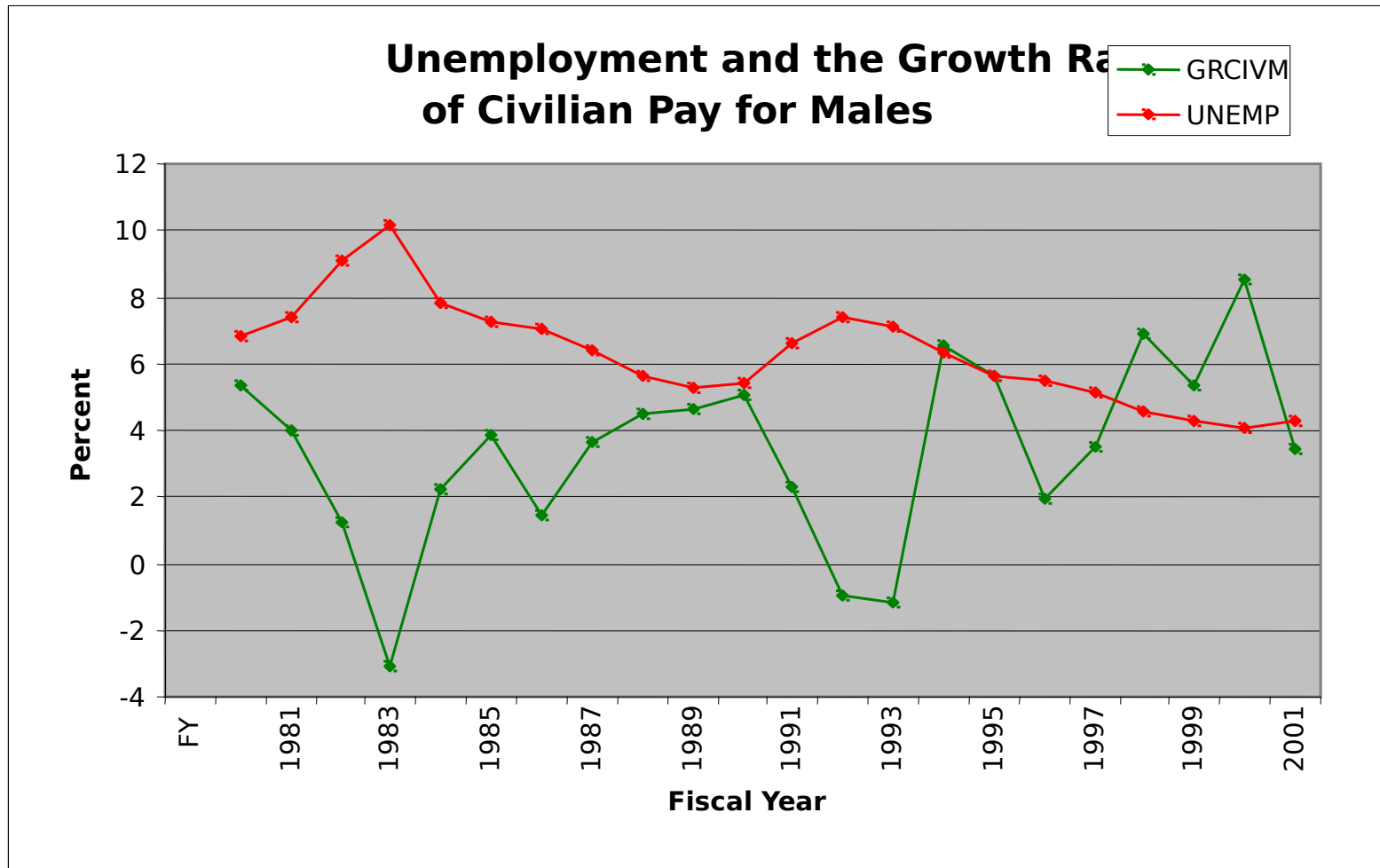


Validation Tests

Oct 00-Sep 01 & Feb 01-Sep 01

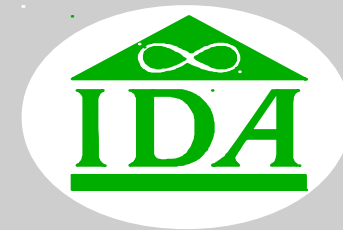


Unemployment and the Growth Rate of Civilian Pay for Males: An Inverse Relationship



Civilian Pay Models

Sample Period 3/80-7/01



Dependent Variable PVCIVGR5 - Estimation by Nonlinear Least Squares
Monthly Data From 1980:03 To 2001:07

Usable Observations 257

Centered R**2 0.780202

Mean of Dependent Variable

Std Error of Dependent Variable

Standard Error of Estimate

Sum of Squared Residuals

Durbin-Watson Statistic

Degrees of Freedom 251

R Bar**2 0.775824

0.0335377711

0.0361418326

0.0171121729

0.0734994419

1.763340

<u>Variable</u>	<u>Coefficient</u>	<u>Std Error</u>	<u>T-Value</u>
1. Constant	0.106068198	0.009561374	11.09341
2. CPIGR	0.353009039	0.056596856	6.23726
3. UNEMP	-0.013654610	0.001500052	-9.10276
4. Mvg Avge{1}	1.052792220	0.054178024	19.43209
5. Mvg Avge{2}	0.481839994	0.045077303	10.68919
6. Mvg Avge{5}	-0.337364585	0.029415547	-11.46892

Dependent Variable PVFCIVGR5 - Estimation by Nonlinear Least Squares
Monthly Data From 1980:03 To 2001:07

Usable Observations 257

Centered R**2 0.725250

Mean of Dependent Variable

Std Error of Dependent Variable

Standard Error of Estimate

Sum of Squared Residuals

Durbin-Watson Statistic

Degrees of Freedom 251

R Bar**2 0.719777

0.0400522750

0.0349040624

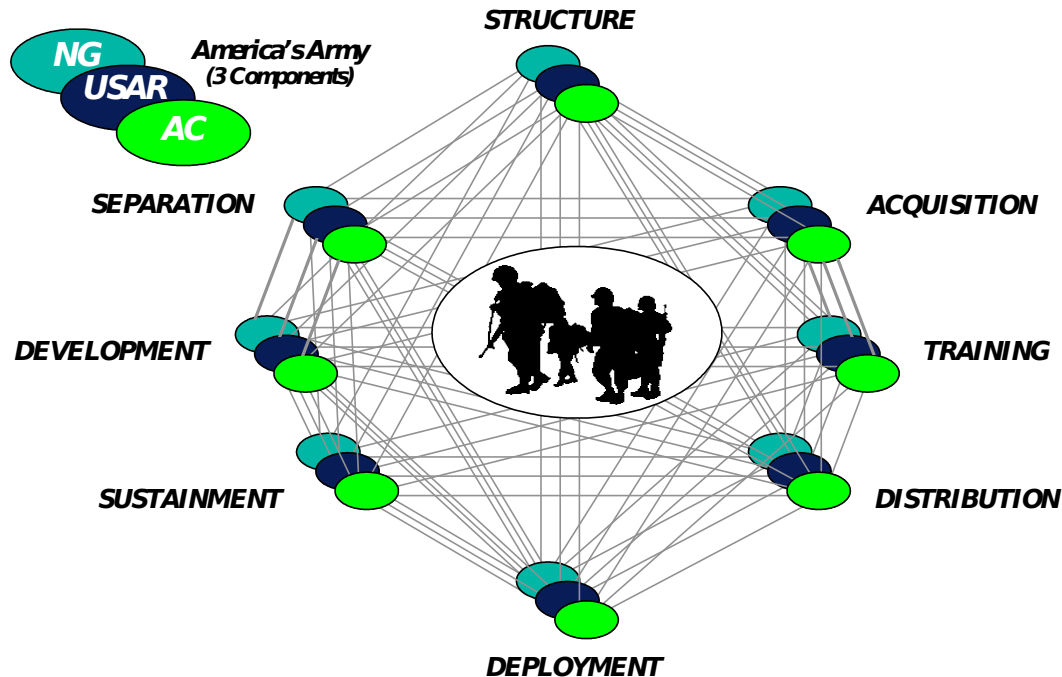
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0.0856900063

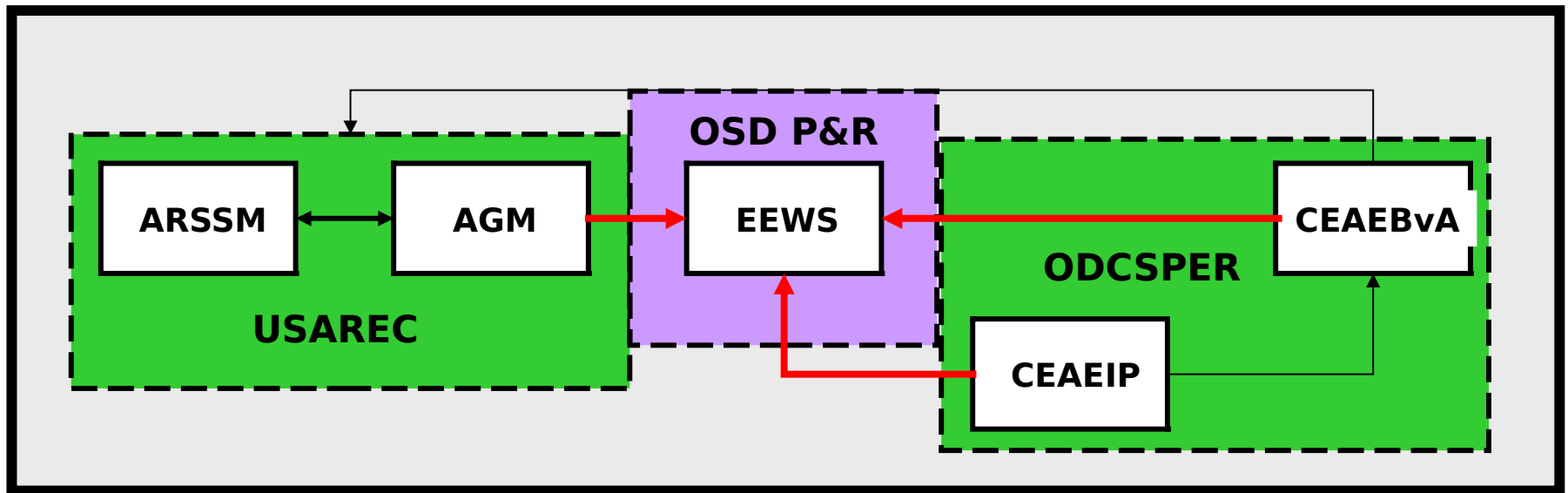
1.710299

<u>Variable</u>	<u>Coefficient</u>	<u>Std Error</u>	<u>T-Value</u>
1. Constant	0.073705911	0.009556263	7.71284
2. CPIGR	0.629444006	0.076211824	8.25914
3. UNEMP	-0.009275110	0.001510026	-6.14235
4. Mvg Avge{1}	0.932140201	0.058409434	15.95873
5. Mvg Avge{2}	0.436564734	0.047809881	9.13127
6. Mvg Avge{5}	-0.363531035	0.035433825	-10.25944

Manpower and Personnel Issues

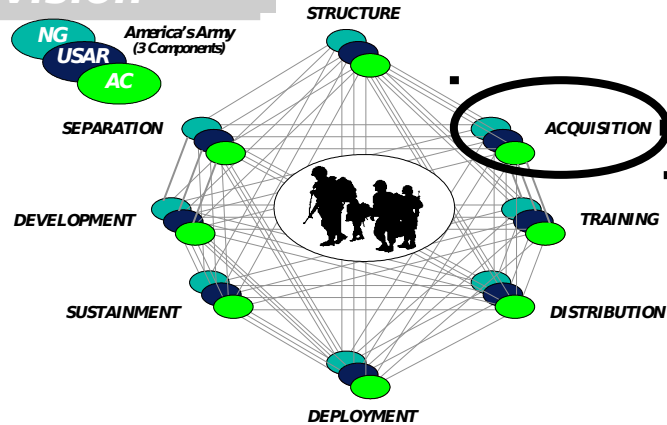


AC Recruiting Relationships

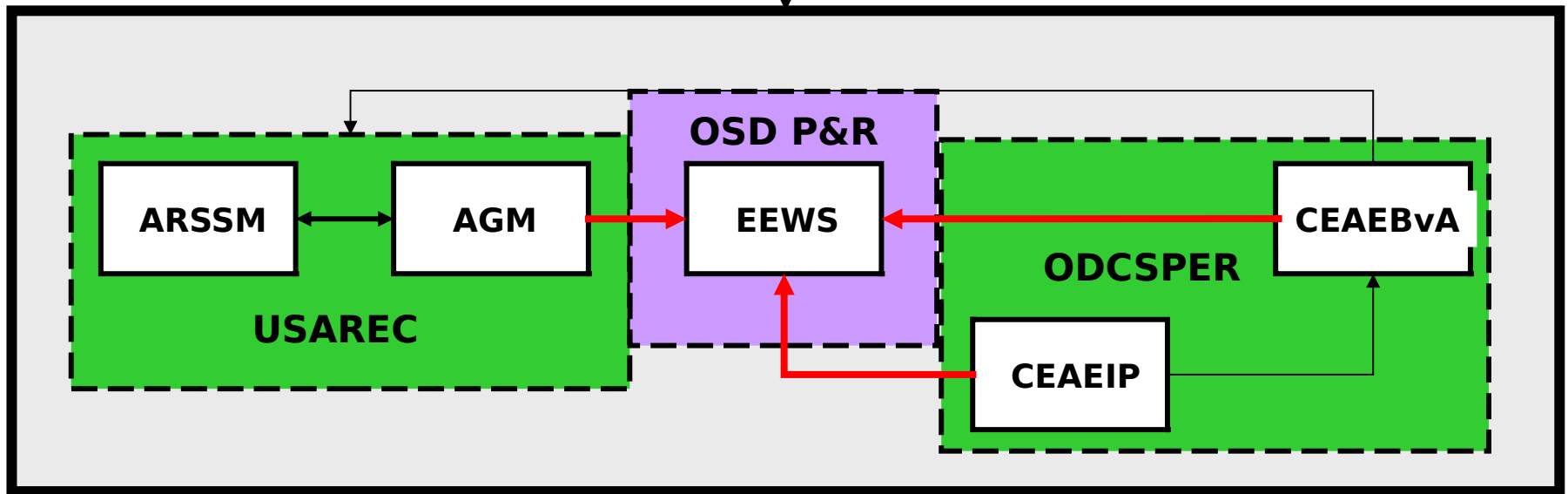


Accession Cost Management System (ACMS)

Total System Interface

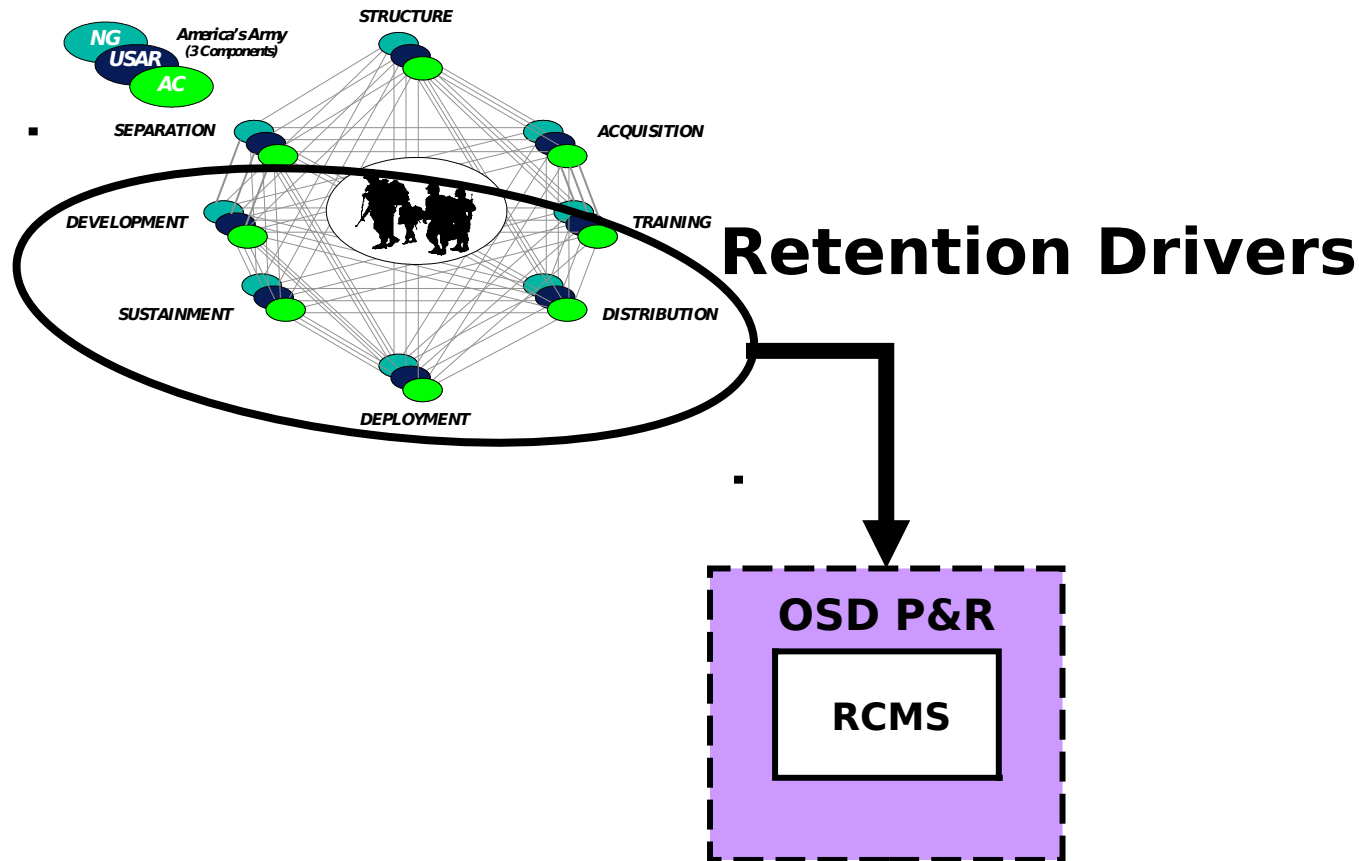


Generates Demand



ACMS Provides Supply

Total System Interface



RCMS improves retention in cost effective ways